

Performance of Photocatalytic Concrete Blended with Artificial Sand and Iron Shavings

D. Satyanarayana, R. Padmapriya

Abstract: Summary: This paper deals in the midst effect of M-sand usage instead of fine aggregate, TiO_2 and iron shavings in terms of volume of concrete to improve the tensile nature of the concrete material. At present larger part of the structures built with solid material namely concrete. Concrete is a composite material arranged by including pounded rocks as course total, normal sand burrowing from conduits as fine total, bond or lime as restricting material and adequate measure of water at specified extents to shape gel. Nowadays the quality of natural sand is degrading and digging at higher depth in water ways leads to land sliding etc. The atmosphere is being polluted due to the harmful gases and toxic byproducts that are released during the production of cement. The present research deals with finding the alternative material for minimizing the problems caused by fine aggregate and binding material. In this context, we are working by means of the stand-in of usual sand by means of manufacture sand producing from crushing of larger boulders into fine particles of required size in cubical shape in various percentages such as 20%, 40%. ... (Volume batching) till occurring optimum percentages. At M-sand optimum percentage, we are partially replacing TiO_2 instead of cement in various percentages such as 4%, 8%... in addition to that we are adding Iron shavings to concrete volume to improve tensile nature of the conventional concrete

Key Words: Photocatalytic Concrete, M-Sand, TiO_2 , Iron Shavings, Compressive Strength, Flexural Strength, Split Tensile Strength, optimal entitlement

I. INTRODUCTION

Foreword:

Concrete be a matrix material prepared by mixing of larger boulders as course total, conventional sand like fine aggregate and cement seeing that binding material to suitable proportions with sufficient water as per water-cement ratio to form gel. Organizing Advancement with Photocatalytic concrete in like way broadens elegant term and make the structure looking like new over postponed stretch of time.

Typically Normal Sand is absent in waterway up to required amount. Burrowing sand, from waterway bed in overabundance amount is dangerous to environment. [13-14] The profound pits delved in the stream bed influences the ground water level.

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D.Satyanarayana, Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai -119, India.(research Scholar, Email: satyanarayanaduttada.civilcom)

R.Padmapriya, Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai -119, India.(Corresponding Author, Email:padmapriyar_77@yahoo.com)

Disintegration of close by land is likewise because of unnecessary sand lifting. Manufactured fine aggregate is familiar as robo sand in construction world prepared by crushing of larger stone boulders into fine particles which will have cubical shape and can play similar role of natural sand in concrete [15-16]. Iron shavings are the waste extracted from nailing of iron rods at industries. [11-12]

The partial replacement of the titanium dioxide improves the strength of concrete and helps in depollution of polluted air and, creates a charge separation of electrons which disperses on the Photocatalytic surface and reacts with external substances, decomposing organic compounds [1-8]. There is an improvement in strength property of the matrix material through addition of iron dissipate as powder form [11]. Usage of manufactured sand not only fills the voids also improve the strength of the concrete by forming strong bonding for long period [17-18].

II. MATERIALS

A. Binding material:

The binding material used in this study majorly consists of OPC 53 Grade and TiO_2 at suitable proportions. When activated by the energy in light, the white pigment creates a charge that disperses on the surface of the photocatalyst, and reacts with external substances to decompose organic compound



Fig. 1 TiO_2

Following are the properties of TiO_2 mentioned in Table1

The below table consist basic parameters of TiO_2 as found that values done with laboratory experiments

Table 1 TiO_2 Properties

S.No	Name of Property	Standard Value
1	Sp.Gravity	2.25
2	Molecular Weight	70.90mg/l

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B. Manufactured fine aggregate:

Manufactured fine aggregate is furnish from crumble of rock material having size less than 4.75 mm size pre-owned in construction of structures. It is a high constitution material. Basalt material is a very fine-grained with visible mineral grains. The average density of basalt material is 3.0 gm/cm³.



Fig. 2 M-Sand

C. Course aggregate

Material which is held on 4.75 mm or more strainer is known as a coarse total. It decreases the expense of cement, since it involves significant volume. The sythesis, shape and size of the total all have critical effect on the crisp, mechanical properties just as weight and shrinkage of the solid. The most extreme size of coarse total utilized in this undertaking is 20 mm and the spans of coarse total utilized are 10mm, 12.5mm and 20 mm individually.

Table 2 Material Properties

S.No	TESTS	MATERIALS			
		Cement	F.A	M Sand	C.A
1	Cement setting Time (Initial)	34 min.			
2	Cement setting Time (Final)	525 Min.			
3	Sp.Gravity	3.14	2.74	2.67	2.74
4	Water Absorption				1%
5	Bulking of sand		6%	6%	

The above table speaks to the essential properties of the Course total and Fine total and is discovered that water retention, Sp.Gravity vales are inside the point of confinement when looked at standard qualities

D. Iron Shavings:

Iron Shavings are brought from nailing of iron rods by using lathe machine in Mechanical department



Fig. 3 Iron Shavings

III. EXPERIMENTAL METHODS

A. Mix Design

Receive Configuration blend for Evaluation of Cement M20 configuration by utilizing IS10262:2009 and IS 456:2000 code arrangements the following are the details.

Grade of Concrete : M₂₀
 Mix Ratio : 1:1.77:2.89
 Water-Cement Ratio : 0.54

All the materials weight and percentage details are mentioned in Table 3&4

Table 3 Mix Details

Mix Type	TiO ₂ (%)	Cement (Kg)	TiO ₂ (Kg)	IS (%)
M ₀	0%	394.00	0.0	0%
M ₁	2%	386.20	7.8	2%
M ₂	4%	378.30	15.7	4%
M ₃	6%	370.40	23.6	6%
M ₄	8%	362.50	31.5	8%
M ₅	10%	354.60	39.4	10%
M ₆	12%	346.72	47.2	-

Table 4 Mix Details

Mix Type	MS (%)	MS (Kg)	NS (Kg)
M ₀	0%	0.00	698.80
M ₁	20%	139.76	559.04
M ₂	40%	279.52	419.28
M ₃	60%	419.28	279.52
M ₄	80%	559.04	139.76
M ₅	100%	698.80	0.00

Note: MS – Manufactured Sand; NS-Natural Sand; IS- Iron Shavings

IV. RESULTS

To inspect the properties of modified Matrix concrete and solidified Cement done different trials in the lab, such as Slump Cone test and compaction factor test to examine workability of Fresh concrete as well as Compressive strength, Split & Flexural strength tests to study about hardened concrete properties. The following are the details.

A. Compressive Strength

Table 5 Compressive Strength details

M-Sand (%)	Compressive Strength (N/mm ²)		
	7 days	14 days	28 days
0%	8.631	15.782	24.66
20%	8.82	16.140	25.22
40%	9.177	16.780	26.22
60%	9.408	17.472	26.88
80%	9.527	17.420	27.22
100%	9.177	16.780	26.22

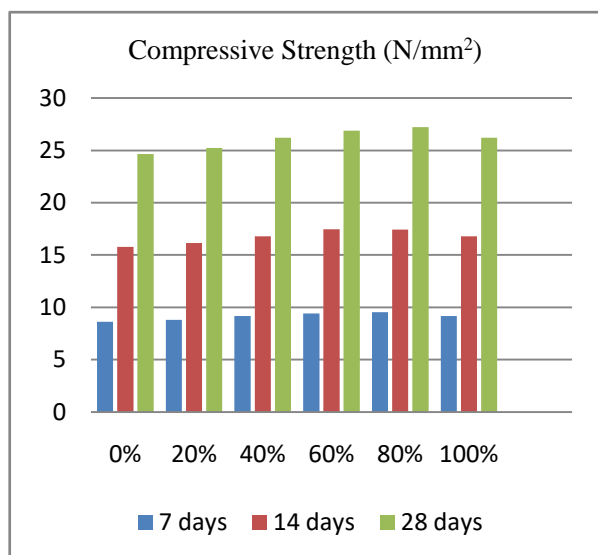


Fig. 4 impact of M-Sand on Compressive Strength of Matrix

The above diagram shows compressive strength outcomes for Traditional Cement subbed with M-Sand and discovered that compressive strength of Ordinary Matrix increment with 100% of M-Sand

Table 6 Compressive Strength details

M-Sand (%)	TiO ₂ (%)	Compressive Strength (N/mm ²)		
		7 days	14 days	28 days
80%	0%	9.527	17.42	27.22
	2%	10.38	18.92	29.66
	4%	10.57	19.34	30.22
	6%	11.04	20.19	31.55
	8%	11.27	20.62	32.22
	10%	11.66	21.32	33.32
	12%	9.05	18.54	26.25

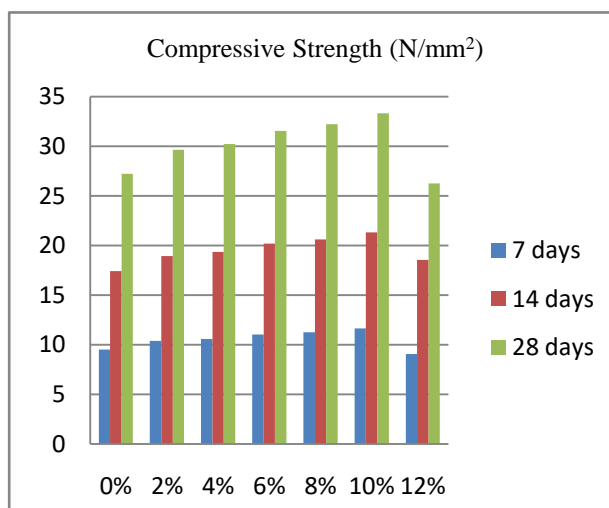


Fig. 5 Impact of TiO₂ on Compressive strength of Matrix
The above graph shows compressive strength results for Photocatalytic Concrete substituted with 100% M-Sand, TiO₂. It is discovered that compressive strength of Photocatalytic Concrete rises upto 33.32N/mm² with adding of 10% TiO₂ further decrease if increases TiO₂ value

Table 7 Compressive Strength details

M-Sand (%)	TiO ₂ (%)	IS (%)	Compressive Strength (N/mm ²)		
			7 days	14 days	28 days
80%	10%	0%	11.66	21.32	33.32
		2%	11.74	21.47	33.55
		4%	11.85	21.68	33.88
		6%	9.64	17.63	27.55
		8%	7.42	13.58	21.22
		10%	7.19	13.15	20.55

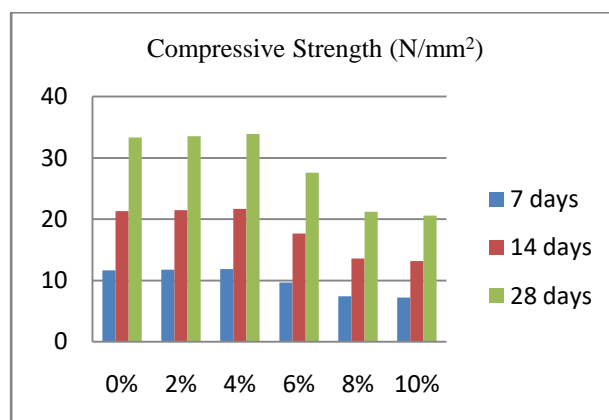


Fig. 6 impact of iron Shavings on Compressive strength of Matrix

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The above graph shows compressive strength results for Photocatalytic Concrete substituted with 100% M-Sand, 10% TiO₂ and Iron Shavings. It is discovered that compressive strength of Photocatalytic Concrete rises upto 33.88 N/mm² with adding of 4% Iron Shavings further decrease if increases Iron Shavings value

B. Split Tensile Strength

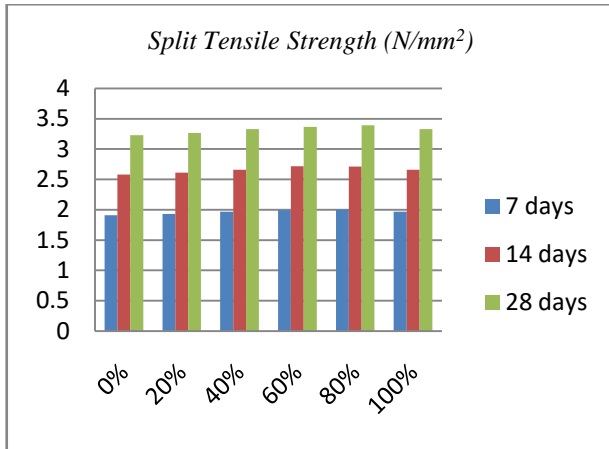


Fig. 7 impact of M-Sand on Split Tensile strength of Matrix

Table 8 Split Tensile Strength details

M-Sand (%)	Split Tensile Strength (N/mm ²)		
	7 days	14 days	28 days
0%	1.909	2.582	3.227
20%	1.931	2.611	3.264
40%	1.969	2.662	3.328
60%	1.993	2.716	3.369
80%	2.006	2.712	3.391
100%	1.969	2.662	3.328

The above diagram shows Tensile strength results for Conventional Concrete substituted with M-Sand and discovered that Tensile strength of Conventional Concrete increase with 100% of M-Sand

Table 9 Split Tensile Strength details

M-Sand (%)	TiO ₂ (%)	Split Tensile Strength (N/mm ²)		
		7 days	14 days	28 days
80%	0%	2.00	2.712	3.39
	2%	2.09	2.831	3.47
	4%	2.11	2.85	3.57
	6%	2.15	2.92	3.65
	8%	2.18	2.95	3.68
	10%	2.21	3.00	3.75
	12%	1.21	2.81	3.425

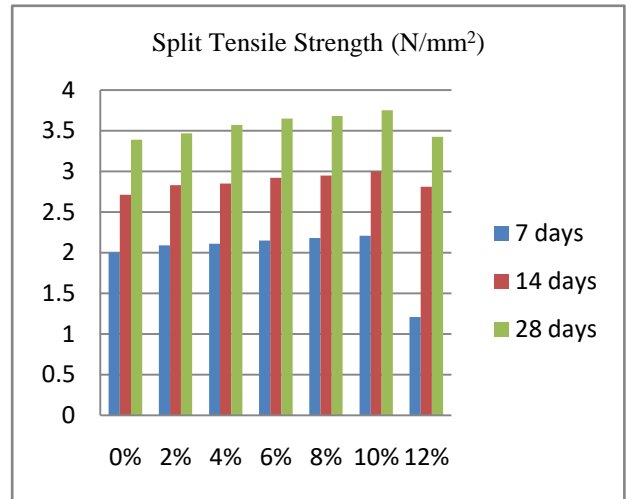


Fig. 8 impact of TiO₂ on Split Tensile strength of Matrix
The above diagram shows Tensile strength results for Photocatalytic Concrete substituted with 100% M-Sand, TiO₂. It is discovered that Tensile strength of Photocatalytic Concrete rises upto 3.75 N/mm² with adding of 10% TiO₂ further decrease if increases TiO₂ value

Table 10 Split Tensile Strength details

M-Sand (%)	TiO ₂ (%)	IS (%)	Split Tensile Strength (N/mm ²)		
			7 days	14 days	28 days
80%	10%	0%	2.39	3.23	4.04
		2%	2.39	3.24	4.54
		4%	2.41	3.25	4.94
		6%	2.17	2.93	3.67
		8%	1.90	2.57	3.20
		10%	1.87	2.53	3.17

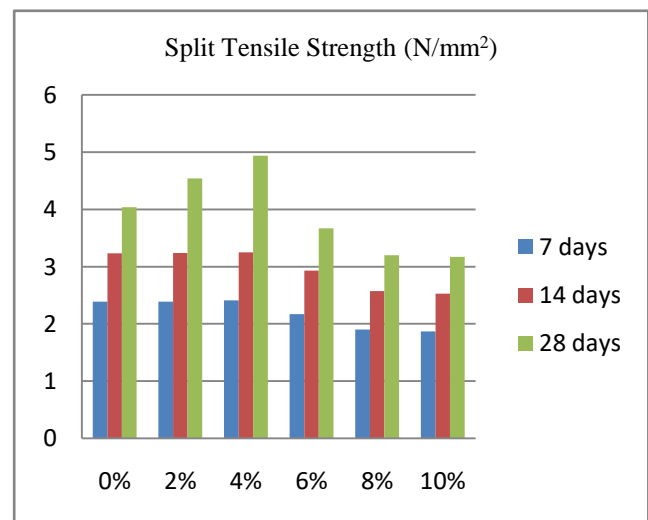


Fig.9 impact of iron Shavings on Split Tensile strength

The above graph shows Tensile strength results for Photocatalytic Concrete substituted with 100% M-Sand,

Table 11 Split Tensile Strength details

M-Sand (%)	Flexural Strength (N/mm ²)		
	7 days	14 days	28 days
0%	2.056	2.780	3.476
20%	2.079	2.812	3.515
40%	2.120	2.867	3.584
60%	2.147	2.925	3.629
80%	2.160	2.921	3.652
100%	2.120	2.867	3.584

10% TiO₂ and Iron Shavings. It is discovered that Tensile strength of Photocatalytic Concrete rises upto 4.94 N/mm² with adding of 4% Iron Shavings further decrease if increases Iron Shavings value

A. Flexural Strength

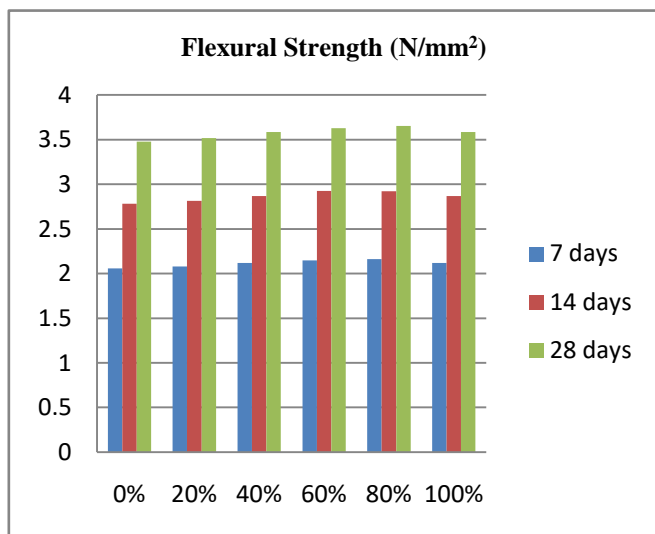


Fig. 10 impact of M-Sand on Flexural strength of Matrix

The above diagram shows Flexural strength results for Conventional Concrete substituted with M-Sand and It is discovered that Flexural strength of Conventional Matrix increase through 100% of M-Sand

Table 12 Split Tensile Strength detail

M-Sand (%)	TiO ₂ (%)	Flexural Strength (N/mm ²)		
		7 days	14 days	28 days
80%	0%	2.16	2.92	3.65
	2%	2.25	3.04	3.81
	4%	2.27	3.07	3.84
	6%	2.32	3.14	3.93
	8%	2.35	3.17	3.97
	10%	2.39	3.23	4.04
	12%	2.18	3.05	3.85

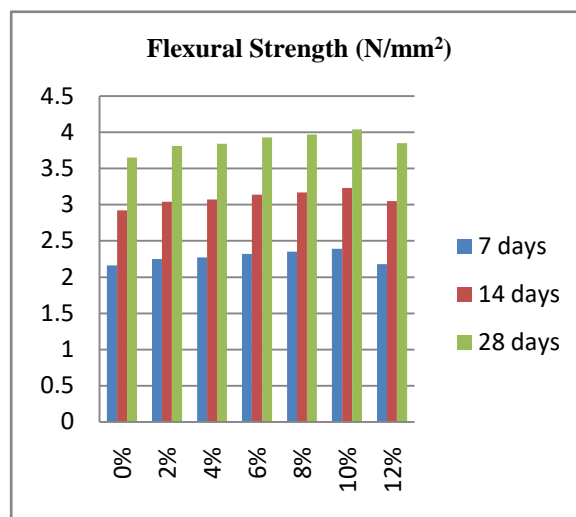


Fig. 11 impact of TiO₂ on Flexural strength of Matrix

Table 13 Split Tensile Strength details

M-Sand (%)	TiO ₂ (%)	IS (%)	Flexural Strength (N/mm ²)		
			7 days	14 days	28 days
80%	10%	0%	2.73	3.69	4.61
		2%	2.74	3.70	4.63
		4%	2.75	3.72	5.10
		6%	2.48	3.35	4.19
		8%	2.18	2.94	3.68
		10%	2.14	2.90	3.62

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The above graph shows Flexural strength results for Photocatalytic Concrete substituted with 100% M-Sand, TiO_2 . It is discovered that compressive strength of Photocatalytic matrix rises up to 4.04N/mm^2 with adding of 10% TiO_2 further decrease if increases TiO_2 value

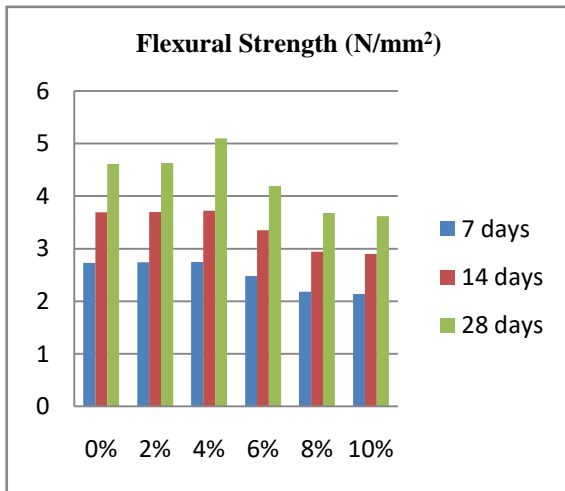


Fig. 12 impact of iron Shavings on Flexural strength of Matrix

The above graph shows Flexural strength results for Photocatalytic Concrete substituted with 100% M-Sand, 10% TiO_2 and Iron Shavings. It is discovered that Flexural strength of Photocatalytic Matrix rises up to 5.10N/mm^2 with adding of 4% Iron Shavings further decrease if increases Iron Shavings value

V. CONCLUSIONS

The following Inferences are exhausted from this examination:

- It is discovered that mechanical properties, for example, quality attributes of the matrix being improved by incomplete swap of M-sand for fine total.
- The perfect level of successor of normal fine total by Fabricated fine total is 80%
- Because of shortage of regular fine total and its elevated expense could renew the selection of fabricated fine total by 100% successor rather than normal fine total.
- It is seen that the compressive strength along with flexure strength of concrete can be improved by fractional substitution TiO_2 as Binding Material
- From the above exploratory outcomes it is demonstrated that, TiO_2 can be utilized as halfway substitution as Cementitious Material and the compressive, flexure qualities are expanded as the level of TiO_2 is expanded up to ideal level. The ideal level of substitution of TiO_2 by Bond is 10%
- The optimum percentage of TiO_2 is 10% for getting maximum compressive strength and it is obtained as 33.32N/mm^2 .
- The optimum percentage of Iron Shavings is 4% for getting maximum compressive strength and it is obtained 33.88N/mm^2
- The Split tensile Strength increments with the expansion in level of Iron Shavings along with 80% expansion in level of M-sand, and 10% of TiO_2 . The maximum tensile Strength is obtained as 4.94N/mm^2 at 4% of Iron Shavings.

- The Flexural Strength also increases with the increase in percentage of Iron Shavings and maximum Flexural strength obtained is 5.10N/mm^2 at 4% of Iron Shavings.
- The percentage of increase in the compressive strength is 26.65% and the flexure strength is 10.48% at the age of 28 days with the replacement of M-Sand, TiO_2 and Iron Shavings at 80%, 10% and 4% respective

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AUTHORS PROFILE



Dr. R. Padmapriya is working as an Associate Professor in the Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai. She obtained her B.E Degree in Civil Engineering from Bharthiyar University in the year 1999 and M.E Degree in Structural Engineering in the year 2001 from Bharthiyar University . She also received Ph.D Degree from Anna University in 2010.

She has 17 years of teaching experience in Engineering College and Universities. She has published papers in National and Intenational conferences and journals. She also guides M.E and Ph. D students in the area of Concrete and Steel Structures.



Mr. D. Satyanarayana Research Scholar in the Department of Civil Engineering, Sathyabama Institute of Science and Technology, Chennai. He obtained his B.E Degree in Civil Engineering from Sri vasavi Institute of Tchnology & Engineering, affiliated to Andhra University in the year 2013 and M.E Degree in Structural Engineering in the year 2015 from Visakha Technical Campus, affiliated to

JNTU University Kakinada.